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Bulletin assembled and edited by Suzanne Stewart

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NEWS AND INFORMATION

From the President's Desk

by David A. Fredrickson
Sonoma State University (Professor Emeritus)

This summer I was pleased by a reminder that the IAOS is truly an international organization. I received an e-mail message from IAOS members Dr. Andrei V. Tabarev of Novosibirsk and Dr. Yaroslav V. Kuzmin of Vladivostok, who expressed the hope that the *Bulletin* would publish a short abstract of a book they will soon be publishing on their investigations of obsidians in the Russian Far East. They acknowledged the help they received from Mike Glascock and Steve Shackley, both past presidents of the IAOS.

Leafing through past issues of the *Bulletin* as I sometimes do, I discovered that what appears to be the beginning of this collaboration was noted in the Summer 1992 edition, *IAOS Bulletin* No. 7. In that issue, the work was described as the "first primary geochemical study of archaeological obsidians from this part of the world." Having identified the presence of six geochemically distinct source groups in the archaeological assemblage, Kuzmin and Tabarev were to begin searching for the geological sources of the material in the fall of 1992. I welcome the publication of the work of our Russian colleagues, and point out that this issue of the *Bulletin* does indeed contain the abstract for their book (page 16). We have hopes that Drs. Tabarev and Kuzmin will soon offer us a more detailed paper for publication in the *Bulletin*.

The growing geographical scope of the IAOS can be seen in the change of venue of the association's annual meetings. In the first several years, the meeting was held in conjunction with the annual meeting of the Society for California Archaeology, as the majority of the officers and general members came from that state and other parts of the Far West. The IAOS met at the SCA meetings for the last time in the spring of 1993, at Asilomar, in Pacific Grove, California. Beginning in 1994, in recognition of the national and international scope of the membership, the IAOS has met in conjunction with the annual meetings of the Society for American Archaeology, which was only coincidentally held in California (Anaheim) that year. In closing, I wish to express my appreciation to Mike Glascock, who made arrangements for the 1999 IAOS meeting in Chicago, the sixth year that the association will meet in conjunction with the SAA. I hope all members (and prospective members) will attend. (See Calendar of Events for details.)

Readers may recall from the last issue (*Bulletin* No. 21) that I mentioned my plan to solicit a brief note or two for the enlightenment of the nonspecialist user of obsidian data. I have been more successful than I thought possible in this regard. I found that Richard Hughes has recently published an article in a book on units of measurement in archaeology and had included what I believe to be a very clear explication of the meaning of obsidian "source," including ambiguities and complexities of the concept. With the permission of Richard and of the University of Utah Press, publisher of the book in which his paper appears, the portion of Richard's paper that covers the concept of obsidian source is reprinted in this issue of the *Bulletin*.

CALENDAR OF EVENTS

October 26-29. Geological Society of America, Annual Meeting. Toronto, Ontario, Canada. GSA Meetings Department, tel: 1-800-472-1988 or 303-447-2020, ext. 133; email:meetings@geosociety.org; http://www.geosociety.org

November. Inter-Congress Meeting of Commission 4, Union Internationale des Sciences Prehistoriques et Protohistoriques. Arizona, USA. Keith Kintigh, Dept. Anthropology, Arizona State University, Tempe, AZ 85287-2402, USA; tel: 602-965-6900; fax: 602-965-7671.

November 7-11. 2nd International Climate and History Conference. Climatic Research Unit, Norwich, United Kingdom. Trevor D. Davies, Climatic Research Unit, University of East Anglia, Norwich NR4 7TJ, United Kingdom; tel: 44-1603-592721; fax: 44-1603-507784.

1999

January 5-6. Recent Advances in Quaternary Biostratigrapy. Cambridge, UK. Danielle Schreve, c/o Dept. of Palaeontology, Natural History Museum, London SW7 5BD, UK; tel: 0044-0171- 938-9258; fax: 0044-0171-938-9277; email: D.Schreve@nhm.ac.uk.

January 10-14. World Archaeology Congress 4. Cape Town, South Africa. Theme: Global Archaeology at the Turn of the Millennium. For information, contact Carolyn Ackermann, WAC4, Congress Secretariat, PO Box 44503, Claremont 7735, South Africa; tel: 27-21-762-8600; fax: 27-21-762-8606; email: wac4@globalconf.co.za; web: http://www.globalconf.co..za/wac4.

March 24-28. The 64th Annual Meeting of the Society for American Archaeology. Sheraton Chicago Hotel and Towers, Chicago, Illinois. For information, contact LuAnn Wandsnider, Program Chair, Department of Anthropology, University of Nebraska, 126 Bessey Hall, Lincoln, NE 68588-0368, (402) 472-8873, email lwand@unlinfo.unl.edu.

March 25. Annual Meeting of the International Association of Obsidian Studies at the SAA Annual Meeting in Chicago (see above). Thursday, 5:00 to 6:00 p.m. (Please check program for location.)

April 23-25. Society for California Archaeology Annual Meeting. Red Lion Inn, Sacramento, California. Contact Bill Hildebrandt or Kelly McGuire (530) 756-3941, or Kathleen Hull (510) 465-4962, FAX (510) 465-1138, or e-mail hull@qal.berkeley.edu.

What is a Source? – Ambiguities Regarding the Sourcing of Obsidian

The following selection has been excerpted from an article by Dr. Richard E. Hughes titled, "On Reliability, Validity, and Scale in Obsidian Sourcing Research," which appears in the volume, *Unit Issues in Archaeology: Measuring Time, Space, and Material*, edited by Ann F. Ramenofsky and Anastasia Steffen and published by the University of Utah Press, 1998. Permission to reprint this selection has been generously granted by both Dr. Hughes and the University of Utah Press.

IAOS requested to publish this excerpt in order to aid our members, especially archaeological users of obsidian sourcing data who may be interested in the ambiguities and complexities regarding the meaning of "source" when used in reference to obsidian. The more complete our understanding of what constitutes an obsidian source, as Dr. Hughes points out, the more effectively we can use and evaluate obsidian sourcing data in our archaeological research. There is much additional information in the second half of his paper, including a discussion of the utilization of obsidian sourcing data in the study of prehistoric trade. We recommend that interested readers refer to the complete text of his paper. (See page 8 for information on this new volume.)

WHAT IS A SOURCE?
GEOLOGICAL, GEOCHEMICAL, AND ARCHAEOLOGICAL CONSIDERATIONS

by Richard E. Hughes

There is perhaps no better place to begin than with the term "source," which has long been employed in geology to specify the point source of origin for a material type. Ericson et al. (1976:218) defined an obsidian source as "a single volcanic event such as an obsidian-perlite dome, flow, aerial bomb scatter or sedimentary stratum containing obsidian." The problem with this definition, from the standpoint of geochemistry, is that (1) sedimentary strata may, depending on local geologic factors, contain obsidians of different chemical types that may themselves be redistributed far from their original eruptive home(s), and (2) it fails to consider that the geologic processes involved in the formation of obsidians in ash-flow sheets may result in the distribution of multiple *primary sources* across vast geographic space (see Hughes and Smith 1993:85-89; Ross and Smith 1961; Smith 1960). With respect to the first point, field observation may be insufficient to determine the number of chemical types occurring in such redeposited contexts; resolution of this issue falls within the geochemical domain. From the standpoint of archaeology, what matters is whether such redeposited occurrences of obsidian were used prehistorically as quarries for raw material. If archaeological evidence shows that they were used, the areal extent of redeposition must be taken into consideration. Some dome and flow obsidians, particularly "young" ones, have been redeposited only a few kilometers; other, "older" glasses may be redeposited tens to hundreds of kilometers from the original source (see, e.g., Hughes and Smith 1993; Sappington 1984; Shackley 1992). In light of these foregoing considerations, the areal correlate of what a source actually "is" may be more difficult to determine in practice than once believed; at a minimum such definitions must be informed by knowledge of the genesis of the obsidian (whether of dome and flow or ash-flow tuff origin), by familiarity with where obsidian occurs in secondary contexts (including where it might be scavenged from older archaeological sites and reused), and by its geochemistry.

The definition of a source (quoted above) refers primarily to an event, with spatial and genetic implications, but such a definition is not well suited to geochemically based obsidian provenance studies because it can convey a misleading geographic exactitude (see Neff, this volume, for a different discussion of source). Obsidian sources are defined, geochemically speaking, on the basis of chemical composition—not spatial distribution. From a geochemical standpoint, it doesn't matter whether an obsidian source is 1/10th of a kilometer in areal extent or 10,000 km^2; what matters is whether the occurrence(s) share(s) a distinctive chemical signature. If significant chemical contrasts are identified, obsidian outcrops located in the same mountain range or volcanic field can be segregated from one another; conversely, if chemical identity is present, obsidians occurring in mountain ranges many miles apart may be combined into a single geochemical unit. Because obsidian sourcing studies rely almost exclusively on geochemistry, the chemical bias of this work has encouraged the use of an alternative term, "chemical group" (also referred to as "chemical type" and/or "geochemical variety"), for describing sources (cf. Jack and Heizer 1968). Use of the term "chemical group" emphasizes geochemical distinctiveness, leaving the spatial dimension to be revised as new distributional information accumulates.

THE BAD NEWS

This distinction between the colloquial use of the term "source" and the use of the term "chemical group" is more than semantic. A source traditionally denotes a *spatial* unit while chemical group is a *geochemical* unit. Both incorporate, by implication, elements of one another: chemical coherence is implied but not explicitly required in the use of "source," whereas some element of spatial circumscription is implied, although not explicitly required, by the use of "chemical group." Importantly, the subtle differences provide the basis for communication difficulties between geochemists and archaeologists. For example, archaeologists have samples geochemically characterized ("sourced") because they want to know where the obsidian came from so that questions regarding past trade/exchange and/or group mobility may be addressed. Leaving aside for the moment difficulties inherent in independently monitoring these latter issues (see below), the "answer" archaeologists get back from the lab isn't always what they expect.

When source analysis is performed by a laboratory, data often are reported to archaeologists in table and graph form, listing artifact-to-chemical type (or source) attribution. Implicit in a geologically informed chemical analysis is the understanding that the term "source" has come to be taken as a shorthand for chemical type and that chemical types may have dramatically different spatial correlates. This may become particularly troublesome archaeologically when obsidians have been redeposited from upland outcrops into streams and incorporated into river gravels, making—in effect— both the primary and secondary occurrences a "source" in a geochemical sense. Archaeological research questions, however, are sometimes phrased at a scale that may be at odds with the spatial resolution that can be provided by chemical analysis.

For example, let's say you've excavated at Snakebite pueblo—located on the Rio Grande in northern New Mexico—and you want to have the obsidian you found there analyzed to get independent evidence to support your hypothesis that Snakebite wasn't occupied year-round, but was just one seasonal stopover for groups moving through the area. You want to know the source of the obsidian, in part, because you think it is likely that the obsidian could have been obtained on brief fall trips into the Jemez Mountains at the same time of the year as the flora and fauna excavated from the site indicate. You have the analysis done, but what you get back from the lab doesn't do much for you. The analyst tells you that your sample contains 30 pieces of glass of the Obsidian Ridge chemical type, but also mentions in passing that there are several places in the lower, mid, and upper reaches of the Jemez where this glass can be obtained. You begin to squirm as the lab person goes on to point out that obsidian of this chemical type has been redeposited and that nodules and pebbles of Obsidian Ridge glass occur in the Rio Grande gravels that could have been picked up and used any time of the year! Your impulse to lash out at this person is fueled by the realization that you'll have to rephrase and rethink the way obsidian data relate to your research question.

This (partly) fictional case illustrates how different analytic frames of reference, with their attendant expectations and assumptions, affect interdisciplinary understandings between archaeologists and geochemists. When the spatial units held by archaeologists are only partly congruent with units geochemically defined, some archaeological research questions (like the hypothetical one played out above) may not be addressed meaningfully with geochemical data. There is an interesting irony here. In the context of this example, geochemical (sourcing) data do not *sensu strictu* "measure what they are designed to measure" (Spector 1981:14) in *archaeological* terms, although they most certainly do measure what they're supposed to in *geochemical* terms. This disjunction is but one example of a more widespread interdisciplinary malaise echoing the earlier plea of W.W. Taylor (1957) for mutual problem-oriented understandings between specialists and archaeologist (for more recent emphasis see Bishop 1992; DeAtley and Bishop 1991; Dunnell 1993; Renfrew 1982).

At a coarse scale, however, the lack of exact geographic congruence between "source" and "geochemical group" can carry a less severe interpretive liability. If one wishes to investigate the time/space distribution of glass of the Obsidian Cliff chemical type in Hopewell archaeological sites in the Scioto River Valley in southern Ohio, it hardly matters that obsidian of this geochemical variety also occurs at the Crystal Springs flow, a scant three kilometers north of Obsidian Cliff in Yellowstone National Park. At the scale of this research problem, it is probably sufficient to know that obsidian of this geochemical type occurs about 1,500 airline miles west-northwest of the Scioto Valley.

To this point, I've tried to emphasize, as others have noted (e.g., Harbottle 1982a), that sources and geochemical groups, despite the fact that they are sometimes mistakenly assumed to be isomorphic, are different analytical units which, depending on geologic circumstances and the degree of resolution (coarse versus fine) required by specific research questions, may or may not be relevant to addressing test implications generated from archaeological hypotheses.

THE GOOD NEWS

But, there are situations in which the unit disjunction between archaeology and geochemistry may open unanticipated and exciting new opportunities for archaeologists to ask more finely grained questions about obsidian use and distribution, in addition to helping expose and render understandable some of the largely unanticipated shortcomings of previous approaches.

To provide some background: In the early days of obsidian sourcing research, entire areas (i.e., mountain ranges, volcanic fields) were often lumped together and referred to generically as "sources" by specialists. This practice resulted largely from the nature of the field sampling method itself, not from the geochemistry. Most geologic samples were few in number, taken on-the-fly from easily accessible areas (often by those unfamiliar with local geology), then handed off to geochemical specialists for analysis. While this reconnaissance phase of sourcing work had the important result of identifying many of the major obsidian chemical types that are still being referred to today, because the sampling method employed was rarely thorough, significant chemical variability among obsidians *within* mountain ranges and volcanic fields often went unrecognized. More recent systematic collection and geochemical analysis of geological obsidian samples from areas in California (e.g., Bacon et al. 1981; Hughes 1986, 1988b, 1989, 1994a; Jackson 1989; Metz and Mahood 1991) and Mesoamerica (e.g., Harris 1986; Mahood 1981, 1988), for example, has revealed significant chemical variability within areas once considered a single geologic source.

With this in mind, consider the following example. In 1972 a small number of obsidian samples taken from road cuts in and around the Casa Diablo area in east-central California were used to define the Casa Diablo obsidian source. Artifacts analyzed from archaeological sites throughout central California and the western Great Basin were matched to the "fingerprint" of Casa Diablo glass on the basis of Rb/Sr/Zr relative intensity data determined by XRF analysis. However, a significant number of artifacts had fingerprints superficially similar to, yet subtly variant from, the dominant "fingerprint" of Casa Diablo obsidian. Although early geologic mapping in the area (Bailey 1974) had revealed a sequence of distinct eruptive units (some of which contained artifact-quality obsidian), little was made of this archaeologically until some years later when more detailed reconnaissance, collection, and chemical analysis was undertaken pursuant to the U.S. Forest Service's mandate to address management of lithic resources on their lands. The results of this recent study (Hughes 1994) showed that not just one, but two chemically different varieties of obsidian occurred in the Casa Diablo area: one (named Lookout Mountain) at the northern side of the caldera, the other (named Sawmill Ridge) venting in areas to the south. Subsequent inspection of quantitative geochemical analyses, coupled with quantitative reanalysis of specimens earlier subjected only to semiquantitative analysis, indicates that these obsidians have rather different *distributional* histories and potentially different use-life histories as well.

The importance of this example isn't only that it shows fine-scale chemical distinctions can be made with improved instrumentation, although that's certainly true. I find it equally interesting to reflect on how this situation came about in the first place. To understand it, we need to consider some historical developments in sourcing research.

In the early days of XRF obsidian sourcing studies, normalized plots of the relative intensities of three elements (usually rubidium ([Rb], strontium [Sr], and zirconium [Zr]) on ternary diagrams worked well to identify and separate different chemical varieties of obsidian in both North America and Mesoamerica when compositions were comparatively distinct (see, e.g., Jack 1971, 1976; Jack and Carmichael 1969; Jack and Heizer 1968; Jackson 1974).[1] But three problems would emerge: the first was that as the inventory of artifact-quality geologic obsidians increased, the Rb/Sr/Zr distinctions once apparent between sources frequently became fuzzy. As a consequence of improved inventory, a unit of measurement that appeared perfectly appropriate to the goals of research at one scale became inappropriate as the scale of research was enlarged. It was *reliable* (i.e., the relative intensity ratios were always the same), but increasingly problematic as new sources were discovered in adjacent regions that yielded the same or overlapping Rb/Sr/Zr ratios (Hughes 1984). The second problem was that if element intensities all varied in the same direction, identical Rb/Sr/Zr ratios would result despite the fact that the absolute concentration of each element might vary significantly. If these intensity ratios alone were relied

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[1] It is important to recognize that prior to the advent of energy dispersive XRF, XRF analysts had the ability to generate quantitative data, but most analyses of archaeological artifacts were done semiquantitatively because generating quantitative data required powdering (grinding up) a portion of the sample for analysis (Nelson et al. 1978; Nelson and Holmes 1979:68). Generating quantitative data was not only time-consuming but it also destroyed all, or a large part, of an artifact. In view of these limiting factors, semiquantitative data, usually presented on ternary diagrams, were considered an appropriate proxy for quantitative data when artifacts were analyzed (see Jack 1976:186-87).

upon, obsidians that were chemically different from one another might be lumped together if they shared the same relative proportions of Rb, S, and Zr. Third, relative intensity plots for Rb/Sr/Zr showed poor agreement with ternary diagram plots determined from quantitative data on the same samples (Hughes 1984), making it difficult to compare semiquantitative and quantitative data directly. In certain circumstances, the acknowledged pitfalls of this approach could be avoided when ratios of other elements (e.g., iron versus manganese; Jack 1976) were employed in concert with Rb/Sr/Zr ternary plots.

Use of relative intensity units also was legitimized by the assumption that sources (as they were understood in light of extant sampling "strategies," sketched above) were homogeneous units. While it is certainly true that obsidians formed in domes and flows are often remarkably homogeneous because they represent the quenched, solid phase of pristine magma, in other cases sequential tapping of laterally zoned magma chambers, combined with roof and wall rock contamination of erupting magma, can yield obsidians of quite different chemical types within the same volcanic field (Hughes and Smith 1993). Although these chemical differences are detectable quantitatively, past sampling strategies, in concert with the measurement units in which *artifact* data were expressed, had an impact on whether intra- or inter-source variation was even recognized in early XRF work. As a consequence of improved sampling and quantitative analysis, some of yesterday's sources have become today's *source areas*, effectively transforming the relations between chemical units and geologic space, complicating the utility of some older analyses and, in turn, altering the kinds of archaeological research questions susceptible to resolution by geochemical techniques.

In this case, technological limitations and concerns with artifact conservation encouraged the use of particular kinds of measurement units to assign artifacts to source, and the assumptions about homogeneity of those units were compromised both by the nature of the sampling and by the limitations of the measurement units to provide the fine-scale resolution required to recognize geochemical variability. The ability to generate quantitative data nondestructively by energy dispersive XRF ushered in a new era in obsidian sourcing studies, which helped overcome some of the unavoidable weaknesses of previous work.

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1976 Prehistoric Obsidian in California II: Geologic and Geographic Aspects. In *Advances in Obsidian Glass Studies: Archaeological and Geochemical Perspectives*, edited by R.E. Taylor, 218-39. Noyes Press, Park Ridge, New Jersey.

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1986 *Silicic Volcanics of the Volcan Tequila, Jalisco, Mexico*. Master's thesis, Department of Geology, University of California, Berkeley.

ABSTRACTS AND ANNOTATIONS OF REPORTS AND PUBLICATIONS

The volume of so-called "gray literature" in archaeology is staggering, making it difficult for researchers who are not "plugged-in" to contract or research archaeology of a certain region or to hear of and gain access to reports. In addition, the proliferation and number of journals, along with the interdisciplinary nature of obsidian and glass studies, make it difficult to keep abreast of all relevant current literature. The IAOS *Bulletin* will alert readers to some of this information by reproducing abstracts and summarizing literature that may be of particular interest to IAOS members.

Balestrieri, M., G. Bigazzi, V. Bouška, E. Labrin, J. Hadler, N. Kitada, A. Osorio, G. Poupeau, K. Wadatsumi, and A. Zuñiga
1998 Potential Glass Age Standards for Fission-Track Dating. In *Advances in Fission-Track Geochronology*, pp. 287-304. P. Van den haute and F. De Corte, editors. Kluwer Academic Publishers, The Netherlands.

Abstract

In this work four glasses proposed as reference materials for fission-track dating were investigated. Samples from various localities from southern Bohemia and Moravia have been studied in order to identify the Moldavite-bearing deposit(s) with negligible track annealing. The remaining three glasses, JAS-G1 (Japan), Roccastrada (Italy) and Macusanite (Peru), yield thermally lowered fission-track ages, and need application of correction techniques. Therefore, following the requirement that a standard should fulfill: "no corrections should be necessary in obtaining the fission-track age", they should be excluded. However, we considered that their potential as reference materials was worthy to be investigated: accuracy may be greatly improved when various reference samples with characteristics similar to those of real samples are available. All these glasses yielded reproducible plateau ages in agreement with available independent ages. The ζ factors computed using track densities corresponding to plateau age determinations are reciprocally well consistent and substantially agree with those of the FTC and Durango apatites, although data suggest a slight systematical deviation. The Moldavites least affected by track annealing are those from the Jankov deposit (Middle Miocene): this glass appears the most convincing potential age standard among those studied here. In principle, the studied glasses for a very promising set of reference materials for standardisation of techniques, interlaboratory comparison and age calibration itself.

Dorighel, O., G. Poupeau, L. Bellot-Gurlet, and E. Labrin
1998 Fission-Track Dating and Provenience of Archaeological Obsidian Artefacts in Colombia and Ecuador. In *Advances in Fission-Track Geochronology*, pp. 313-324. P. Van den haute and F. De Corte, editors. Kluwer Academic Publishers, The Netherlands.

Abstract

We dated by the fission-track method eighteen samples of obsidian glass. Of these, seventeen were artefacts collected in prehispanic archaeological sites from Ecuador and Colombia and one comes from a secondary obsidian source located in southern Colombia. When our data are compared to (i) the fission-track ages of obsidian from volcanic sources and (ii) the PIXE chemical composition of the same artefacts and of samples from obsidian sources, eight discrete age/composition groups appear.

Fifteen artefacts might come from a single known source; three others from sources in the Sierra de Guamani (East of Quito): one from the Mullumica rhyolitic flow and two from the Quiscatola/Yanaurcu sources. A fourth artefact might come from the South Colombia source of Rio Hondo. At least five other sources are necessary to account for the variety of ages and compositions found in the artefact collection studied.

Elam. J., L.M. Anovitz, R. Riciputi, and D.R. Cole
1998 Dating Obsidian Artifacts by SIMS. Paper presented at the 63rd Annual Meeting of the Society for American Archaeology, Seattle, Washington.

Abstract

While obsidian hydration dating has been widely applied in various regions of the world, results have generally been unsatisfactory. This has led to diverse attempts at refining the method in order to increase reliability. We will present a new method of dating obsidian artifacts using Secondary Ion Mass Spectrometry (SIMS). This method directly measures the diffusion chemistry occurring in the glass surface and avoids the pitfalls of optical measurement.

We will discuss the use of finite difference modeling for dating and also address the possibility of obtaining temperature and humidity constraints directly from the chemical processes in the hydration rind.

Glascock, Michael
1998 Sourcing Obsidian Artifacts by Neutron Activation Analysis. Paper presented at the 63rd Annual Meeting of the Society for American Archaeology, Seattle, Washington.

Abstract
Neutron activation analysis (NAA) is one of the most powerful analytical techniques for sourcing obsidian artifacts because of the large number of elements that can be measured. Over the past decade, the Archaeometry Lab at MURR has been extremely active in the characterization of obsidian sources in the Western Hemisphere, especially in Mesoamerica. Following the analysis of several thousand artifacts from Mesoamerican sites by NAA, only a small handful of artifacts remain with their sources undetermined. During this workshop, a description of the technique will be presented and results from Mesoamerica will be used for illustration.

Gottesman, M.
1998 Measuring Effective Hydration Temperature. Paper presented at the 63rd Annual Meeting of the Society for American Archaeology, Seattle, Washington.

Abstract
Over the last two years UCLA has become a major participant in the obsidian hydration dating method and in the application of laboratory-determined hydration rates. The laboratory also manufactures the saline-based diffusion cells for the measurement of site temperature and relative humidity. In this session, we will discuss the process of cell manufacture, their in-field use and importance for obsidian hydration dating. In addition, we will present newly acquired data which demonstrate successful applications and potential pitfalls.

Hildebrandt, William R.
1998 Prehistoric Production and Exchange of Obsidian from the Coso Volcanic Field. Paper presented at the 32nd Annual Meeting of the Society for California Archaeology, San Diego.

Abstract
Several years of archaeological research in the Coso Volcanic Field reveal a dynamic history of obsidian use spanning at least 10,000 years. Analysis of over 90 chronologically discrete assemblages indicates that prior to 2800 B.P., use of the area was largely restricted to generalized, short-term exploitation of lag quarries. Between 2800-1000 B.P., a major reorganization in production strategy took place, as primary flows were extensively exploited, supplying obsidian to off-quarry biface production stations and, ultimately, to consumer populations in cismontane California. After 1000 B.P., the Coso production-exchange system collapsed, probably due to a variety of factors. It is hypothesized that the demand for obsidian decreased due to a greater reliance on the bow and arrow (and the use of core-flake rather than biface reduction), while increases in territoriality may have inhibited its supply, not only by restricting direct access, but also by increasing the number of exchanges required to move material equivalent distances across the land.

Jones, M., P. Sheppard, and D. Sutton
1997 Soil Temperature and Obsidian Hydration Dating: A Clarification of Variables Affecting Accuracy. *Journal of Archaeological Science* 24:505-516.

Abstract
The results of a year-long soil temperature monitoring programme are presented. They increase understanding of the magnitude, spatial scale and predictability of variation in soil temperature regimes which affect obsidian hydration dating. It is demonstrated that current archaeological temperature estimation methods, either due to design or application, do not provide temperature control at a spatial resolution fine enough to control for microregional variation. This failure is resulting in significant and avoidable dating errors.

Loyd, Janine M., Sue Ann Schroder, and Thomas M. Origer
1998 Identifying the Relationships of Hydration Band Development between Obsidian Sources Using Artificially Accelerated Hydration. Part I: Medicine Lake Highland and the Warner Mountains. Paper presented at the 32d Annual Meeting of the Society for California Archaeology, San Diego.

Abstract
The Sonoma State University Obsidian Laboratory has been accelerating hydration development on obsidian from various chemical source locations. The purpose of this research is to identify the relationships among obsidian hydration rates for different sources. At the Northern Data

Sharing Meeting in Yosemite, we gave a brief presentation of our research findings. With data now at our disposal we can more fully present our findings, with numbers that permit adjusting hydration measurements from one source to be directly comparable with measurements of a different source. In addition, we will discuss the application of this type of research in analyzing obsidian hydration data.

McGuire, Kelly R.
1998 Late Period Obsidian Procurement and Subsistence Regimes: Results of Recent Data Recovery Excavations along the East Flank of the Coso Volcanic Field. Paper presented at the 32d Annual Meeting of the Society for California Archaeology, San Diego.

Abstract

Archaeological components located east of the primary obsidian quarry zones in the Coso Volcanic Field are characterized by two general feature/assemblage categories: (1) secondary biface reduction stations, and (2) processing features and tool scatters unrelated to lithic production. None of the former post-date 1,000 B.P., suggesting that large-scale biface production ended at this time. Most of the latter post-date 1,000 B.P. and are more emblematic of local subsistence organization. This critical 1,000 B.P. timeframe has been tied to various major social and environmental transformations in the western Great Basin. These changes are further explored with data from the Coso Volcanic Field and other recent investigations in the western Great Basin.

Peterson, Jane, Douglas R. Mitchell, and M. Steven Shackley
1997 The Social and Economic Contexts of Lithic Procurement: Obsidian from Classic-Period Hohokam Sites. *American Antiquity* 62(2):231-259.

Abstract

The social and economic organization of obsidian procurement has been a topic of particular interest in southwestern archaeology as a result of recent work identifying and characterizing a number of sources throughout Arizona, New Mexico, and northern Mexico. Recent studies have attempted to explain temporal and spatial variability of obsidian distribution in the larger context of regional exchange networks, socially bounded territories, and elite redistributive efforts. This study reviews the current state of research as reflected in three models. Patterns in obsidian source diversity and reduction stage data are assessed relative to model expectations and an analysis of obsidian acquisition and distribution. The likelihood of elite members of an increasingly formalized socioeconomic system playing a role in these processes should be considered, while at the same time noting that kin-based raw material procurement and ritual item mobilization may explain many of the obsidian patterns. The emerging perspective suggests that obsidian moved in a variety of spheres, concurrently serving a number of social and economic purposes. This study highlights the importance of modeling individual, nonlocal commodities before attempting to generate monolithic exchange models.

Shackley, S.
1998 X-ray Fluorescence Analysis of Obsidian. Paper presented at the 63rd Annual Meeting of the Society for American Archaeology, Seattle, Washington.

Abstract

There have been a number of advances in energy-dispersive and wavelength x-ray fluorescence spectrometry (XRF) that have made the analysis of archaeological obsidian both more precise and accurate, while providing easily interpretable data for the archaeometrist and archaeologist. A number of examples of archaeological projects from the Berkeley Archaeological XRF Lab using data from the American Southwest and northern Mexico will be presented for discussion.

1998 Gamma Rays, X-rays and Stone Tools: Some Recent Advances in Archaeological Geochemistry. *Journal of Archaeological Sciences* 25(3):259-270.

Abstract

Recent advances in instrumental technology are providing archaeologists with enticing opportunities in the chemical analysis of geological materials. These advances, however, have not necessarily been employed with a great degree of communication between the archaeologists who study stone tools and structural stone, and the archaeometrists who analyse those materials. While communication has improved greatly in the last several years, progress can still be realized. Recent archaeometric attempts to unravel issues in stone-tool use, continuing work in the understanding of chemical variability and secondary depositional effects in archaeological sources of obsidian and chert, and discussions of the best methods to quantify results all dominate the interface between lithic technology and archaeometric attempts to solve these problems. These issues will be with us well into the next century and deserve some discussion here and now.

Skinner, C., and J. Thatcher
1998 The Obsidian Hydration Dating Method: Preparation and Hydration Rim Measurement of Artifacts. Paper presented at the 63rd Annual Meeting of the Society for American Archaeology, Seattle, Washington.

Abstract

The obsidian hydration dating method provides a unique opportunity to directly date the manufacture of artifacts and may also furnish valuable chronological information in cases where other dating methods are not applicable. When a fresh surface of obsidian is exposed, it begins to absorb environmental water at a regular rate, eventually producing a visible and measurable hydration rim. In a demonstration of the method, we will prepare an obsidian artifact from an Oregon archaeological site for measurement and will determine the width of the hydration rim using video microscopy methods.

Stevenson, C.
1998 Revising the Working Assumptions of Obsidian Hydration Dating. Paper presented at the 63rd Annual Meeting of the Society for American Archaeology, Seattle, Washington.

Abstract

Recent laboratory studies have demonstrated that the quantity of structural water present within the unhydrated glass is the principal variable that controls the rate at which the hydration rim forms. As a result, it is now essential the measurement of obsidian structural water content be integrated into the dating process. The impact of this new variable on sampling and chemical characterization is discussed and illustrated with a case example from the southwestern United States.

Tenorio, D., A. Cabral, P. Bosch, M. Jimenez-Reyes, and S. Bulbulian
1998 Differences in Coloured Obsidians from Sierra de Pachuca, Mexico. *Journal of Archaeological Sciences* 25(3):229-234.

Abstract

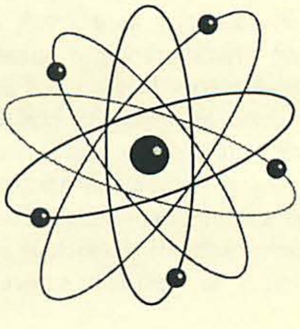
The structural and chemical features of two obsidians from the pre-Hispanic quarry in the town of Nopalillo, Sierra de Pachuca, Hidalgo, Mexico, are presented here. The obsidians were collected at a single site. The most common sample is green, glassy, and transparent and the other is green-greyish and opaque. Both samples were found to have similar elemental composition.

In order to explain the differences in colour, we studied the morphology and structure of both samples using various techniques. Mössbauer and electron paramagnetic resonance (EPR) techniques showed that both samples had the same iron oxidation states as the parameters and relative intensities (%) of the signals from Fe^{2+} and Fe^{3+} were similar, although in the green-greyish obsidian a low-spin Fe^{3+} species was found which was not observed in the green obsidian. X-ray diffraction (radial distribution function) showed that short-range order due to interatomic distances was the same for both samples; however they differed clearly in their macroscopic structure. The green obsidian surface was found to be smooth and homogenous and the green-greyish obsidian surface full of large crater-like holes. The presence of holes did not affect the surface area of the green-greyish obsidian.

Tykot, R.
1998 Obsidian Studies in the Old World: Recent Advances in Methods, Research Design and Interpretation. Paper presented at the 63rd Annual Meeting of the Society for American Archaeology, Seattle, Washington.

Abstract

Obsidian research in Europe, the Near East, and Africa has come a long way since the pioneering characterization work by Renfrew and others in the 1960s. In addition to new and improved analytical methods, and more complete knowledge of obsidian sources, the focus of modern research has shifted to emphasize the integration of provenance data with reduction technology, usewear information, and the interpretation of dynamic patterns of economic, social, and political change. Obsidian hydration dating has produced complementary information on taphonomic processes and artifact reuse, while advances in measurement and calibration have greatly improved its chronological accuracy.



SHORT REPORTS

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Short Reports provides an archaeological context in which to report obsidian research and related information. This issue we have two contributions: a report from Glen Wilson on his preliminary work with obsidian sourcing under the microscope; and Tom Burge and Bill Mc Matthews' report on their annual trips to obsidian sources in California and Nevada. I accompanied the Glass of '98 for part of their excursion this year, and I highly recommend it for anyone with an interest in California and Nevada obsidian sources.

Please keep the contributions coming. Your reviews of recent studies, research in progress, older findings, and regional-, site-, and artifact- specific summaries are most welcome.

An Annual Trip to California/Nevada Obsidian Quarries

by

Thomas L. Burge
William Mc Matthews

It began with the **Glass of '96**. With luck, it will continue into the 21st. Century. We met in early 1995 and as archaeologists new to California's Sierra Nevada mountains we began to discuss the challenge of learning what we needed to know to work effectively in the field. Bill, as the archeologist on the Hume Lake Ranger District, Sequoia National Forest is based out of Dunlap, California. Tom, as the archeologist for Sequoia and Kings Canyon National Parks is based out of Three Rivers, California. The areas we are responsible for share a common boundary and subsume slightly over one million acres of public land in the southern Sierra Nevada. Prehistorically, these lands have been used for at least 5,000 to 6,000 years. At previous points in the past, the evidence suggests significant movement and trade E/W along the river valleys and across the passes of the snow-capped ranges.

Perhaps the single most easily recognizable evidence of Native American use in the Sierra Nevada is the surface presence of obsidian tools and debris. What caught our interest initially was the well-reported knowledge that none of the obsidian we encountered on our 'westside' acreage occurred there naturally; all of it had to be carried in from the volcanic landscapes of the 'eastside', from today's high desert lands of extreme eastern California and western Nevada. What challenged us the most was the need to quickly develop some sense of the types and sources of the obsidian we encountered. On-going study of the area's obsidian quarries has occurred since the 1970s (see Bettinger 1977, 1991; Hughes and Bettinger 1984; R. J. Jackson 1984; T. L. Jackson 1974, 1984, 1986; Moratto 1972; and Roper Wickstrom 1992). These research efforts remain critical references in understanding the use and trade of obsidian in the southern Sierra Nevada and we worked to familiarize ourselves with them. Additionally, we realized that visits to the most common sources could only be beneficial. Beyond seeing something of a source's range of variation and the nature of on-site production, an appreciation of the terrain and accessibility would be helpful in understanding the movement of peoples and materials. We also felt immediately that any field trip to eastside obsidian sources should be fun!

With no particular embarrassment of our 'new guy' ignorance we began to make telephone calls and solicit help and interest. Tom, aficionado of the bad pun, coined the title **Glass of '96** for that first field trip. Linda Reynolds and Wally Woolfenden of the Inyo National Forest, Rob Jackson (Pacific Legacy, Inc.), and others agreed to be part of the initial gathering. We worked up flyers and relied on friends and colleagues to spread the word. We settled on a June weekend and stressed from the outset that we wanted the field trip to be casual and fun. The weekend exceeded our expectations. A group of circa 35 visited Bodie Hills, Mono Craters, and the Casa Diablo quarry areas. Everyone seemed to enjoy the tours and expressed interest in trying to make the get-together an annual event.

The second year, the **Glass of '97** of course, saw 25 folks gathering in the wonderfully remote quarries of the Truman Meadows-Queen Valley area of the White Mountains of border Nevada. On-site expertise was offered by Wally Woolfenden and Nicholas Faust. It was another productive and fun weekend and even included a few stops at prehistoric pictograph sites.

The **Glass of '98** moved a little further north. Hosted by Mark Swift of the Bridgeport Ranger District of the Toiyabe National Forest, upwards of 40 people met in late June to tour the Mt. Hicks and Pine Grove Hills quarries of western Nevada. Periodically, dramatic views of the Sierra Nevada could be seen to the west, as the abrupt eastern escarpment of the range was only approximately 40 air miles distant. A connection was thus easy to imagine between the accessible flows of high quality obsidian, well-adapted Great Basin groups, travel into and eventually across the Sierra Nevada, and the inevitable contact with 'westside' groups in California. The dynamics of these movements and contacts continue to be worked out. Obsidian, with its ability to be sourced and hydrated will continue to play an instrumental role in helping to reconstruct the details of this past. With luck, interested parties will continue to meet for a few days each summer to tour quarry sites, share knowledge, and enjoy some time together. Plans are now being made for the **Glass of '99**, with a hoped-for visit to the Coso Volcanic Field.

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1972 *A Study of Prehistory in the Southern Sierra Nevada Foothills, California*. Ph.D. dissertation, Department of Anthropology, University of Oregon, Eugene.

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1992 *A Study of High Altitude Obsidian Distribution in the Southern Sierra Nevada, California.* Master's thesis, Department of Anthropology, Sonoma State University, Rohnert Park, California.

Obsidian Quarry Identification under the Microscope

by

Glen B. Wilson,
California State University, San Jose

Anyone who has measured several hundred hydration rims under a microscope becomes aware that samples from different quarries have different crystal patterns. Variations occur in crystal structure, orientation, alignment, color, and numbers. Those technicians who offer visual sourcing along with hydration-rim measurements often use these microscopic variations along with observations of the pre-cut sample to guess at the quarry source. Recently in my work as director of the San Jose State University Obsidian Hydration Laboratory, I have been attempting to develop a series of crystallographic descriptions for all of the different types that occur for each of the quarries whose obsidian is commonly found in sites in the southern San Francisco Bay Area.

Here at the Hydration Lab we have 232 slides whose quarry sources have been determined by trace mineral analysis. As is usual in the Bay Area, most of these samples came from the Napa Valley source (61%), but 13% each were identified as being from the Casa Diablo and Bodie Hills sources in the eastern Sierra, 5% from Annadel in Sonoma County, and much smaller amounts from the Mt. Hicks, Mono Craters, Mt. Konocti, Coso, and Dutch Flat sources.

After closely observing all of this group of slides several times, I have separated them into distinct types: 5 for Napa, 3 for Annadel, 4 for Casa Diablo, and 4 for Bodie Hills. Using these descriptions and blanking out the XRF results, I have been able to achieve better than a 90% agreement with the XRF determinations for the 232 slides. I am calling this method IUM (Identification under the Microscope).

The main problem with IUM is the similarity between some of the individual types from different quarries. Casa Diablo and Bodie Hills are the most alike, and distinguishing between them resulted in most of the errors. However, since these two seem to hydrate at about the same rate (Tremaine 1990), these discrepancies would not materially affect the hydration curves or most interpretations of the results.

To use this system well, and especially to share it with others, it would most likely be necessary to take colored photographs of each distinct type, but my investigation has not yet reached this stage. At the present time, what I have done would only apply to the southern Bay Area. Whether it would work at all in areas a few hundred miles away would depend on whether there was enough distinctive differences in the crystallography between obsidian imported from quarries available to that area. The IUM system would be particularly useful for sites that, for various reasons, have a lot of tiny pressure flakes too small for XRF analysis or easy visual sourcing.

Following is a list of the descriptions I am using for the southern San Francisco Bay Area.

Napa #1. The matrix may be colorless to fairly dark. There are many crisscrossed, randomly oriented, black, hair-like crystals with a net-like appearance, often with small differently shaped, black crystals and occasional larger, colored crystals.
Napa #2. Usually has a light-colored matrix with a few randomly oriented, widely separated, hair-like black crystals with some small, various-shaped, black, blue, and yellow crystals.
Napa #3. A brown to dark brown matrix, with the characteristics of any or all of the other Napa varieties.
Napa #4. Usually has a light-colored matrix with some hair-like black crystals, mostly in parallel rows, and with occasional larger colored crystals and differently shaped smaller black crystals.
Napa #5. Light-colored matrix with widely spaced, variously shaped, black crystals and occasional larger, colored crystals.

Annadel #1. Light-colored matrix with a few scattered colorless crystals, with many small, differently shaped black crystals and some large, blue and yellow rectangular crystals.

Annadel #2. Many parallel and often tightly packed elongated yellow crystals with some scattered small black crystals. Has a definite yellowish appearance.
Annadel #3. Mostly a blue-colored matrix with many large, blue-colored crystals. Overall blue appearance.

Casa Diablo #1. Generally light- to medium-colored matrix with many parallel, elongated, often tightly packed, thin colorless crystals, with differently shaped, small black crystals and occasional larger blue and yellow crystals.
Casa Diablo #2. Many parallel, elongated, colorless crystals with some hair-like aligned black crystals and some larger, rectangular blue and yellow crystals.
Casa Diablo #3. Dark greyish matrix with mottled overall yellow crystalline appearance and some black crystals. Sometimes difficult to pick out individual crystals.
Casa Diablo #4. Usually light-colored matrix with many, sometimes crisscrossed, hair-like black crystals, often with spider-like concentrations. Often has some colorless to light-blue elongated crystals.

Bodie Hills #1. Light-colored matrix with scattered, elongated, quadrilateral, blue and yellow crystals, often randomly oriented, with some parallel alignments and a few differently shaped, black crystals.
Bodie Hills #2. Light- to dark-colored matrix with some darker cloud-like areas and scattered to tightly packed colorless crystals, mostly parallel, but with occasional changes in orientation. Occasional larger blue and yellow crystals.
Bodie Hills #3. Medium-colored matrix with alternating rows of tightly packed, thin, colorless and black hair-like crystals, often with some spider-like concentrations.
Bodie Hills #4. Brown matrix with elongated, large, parallel, rectangular yellow crystals.

The microscope used in these determinations is an Olympus BH2, with a 10-power single eyepiece, a 40-power objective lens, and with a polarizing attachment. The trace-mineral analyses were made by Tom Jackson and by Biosystems Analysis, Inc.

Reference Cited

Tremaine, Kim J.
1990. A Relative Dating Approach for Bodie Hills and Casa Diablo Obsidians Derived from Accelerated Hydration Experiments (Abstract). *International Association for Obsidian Studies Bulletin* 2:4.

Reminder

– Effects of Fire on Obsidian – Symposium Contributions Sought

At our annual meeting in Seattle, the IAOS voted to co-sponsor a symposium at the 1999 Society for California Archaeology annual meeting, in Sacramento, on the effects of fire on obsidian. Those of you who have been doing research on this topic, please contact Tom Origer, Sonoma State University, at the following address for further information on contributing a paper:

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For reports on recent studies on the topic in California, see Technotes in IAOS *Bulletin* 19 ("Adding a Little Fuel to the Fire: Some Thoughts on Fire and Obsidian Hydration" by Anderson and Origer) and *Bulletin* 20 ("Cooked Obsidian" by Origer, Loyd, and Schroder).

Russian Research Now in Press

Glascock, M.D., Y.V. Kuzmin, V.K. Popov, M.S. Shackley, and A.V. Tabarev
[n.d.] *Obsidian in the Archaeological and Geological Contexts of the Maritime Region, Russian Far East.* Institute of Archaeology & Ethnography, Novosibirsk. In press.

This book is a result of the joint project conducted by an international Russian–American team between 1992-97. Primorye (in the Maritime region, Russian Far East) became the first district in all of Russia where obsidians from archaeological collections (about 90) were identified with several regional sources according to geological and geochemical characteristics. Special chapters in the book focus on (1) recent obsidian studies in the world (Mediterranean, Near East, British Columbia, Mesoamerica); (2) technological (experimental) reconstructions of ancient techniques (microblade, bipolar, burin, pressure points, etc.) used in Primorye since the Final Paleolithic (13 000-11 000 BP) up to the Early Iron Age (1800-1500 BP); (3) regional characteristics of volcanic glasses and their sources; and (4) the correlation of geological and archaeological data (utilisation of different sources in different chronological periods, long-distance exchange, possible migrations from other regions, perspectives for future research, and so on). In 1995-97 the project was partly supported by the Russian National Science Foundation for Humanities.

– Reminder –

Archaeological Obsidian Studies: Method and Theory

Edited by M. Steven Shackley, University of California, Berkeley
Volume 3 in Advances in Archaeological and Museum Science, Plenum Press

Description.
The use of obsidian archaeometry has expanded dramatically in the last 20 years, due partly to technological advances and partly to recognition by archaeologists that archaeometrists provide much more information than mere measurement. Since the mid-70s, however, no book has appeared to document the latest advances. Archaeological Obsidian Studies, the only volume of its kind in print, corrects this situation by presenting the current state of the science, from volcanic glass geochemistry to hydration analysis. Archaeologists, museum professionals, geologists, materials scientists, and students will find this volume to be an indispensable guide to modern archaeometric theory and methodology, both in the lab and in the field.

(Find out more at http.//www.plenum..com)

Contents: Current Issues and Future Directions in Archaeological Volcanic Glass Studies: An Introduction (M.S. Schackley). A Systematic Approach to Obsidian Source Characterization (M.D. Glascock et al.). Mediterranean Islands and Multiple Flows: The Sources and Exploitation of Sardinian Obsidian (R.H. Tykot). Intrasource Chemical Variability and Secondary Depositional Processes: Lessons from the American Southwest (M.S. Schackley). Characterization of Archaeological Volcanic Glass from Oceania: The Utility of Three Techniques (M.I. Weisler, D.A. Clague). Application of PIXE-PIGME to Archaeological Analysis of Changing Patterns of Obsidian Use in West New Britain, Papua New Guinea (G.R. Summerhayes et al.). Factors Affecting the Energy-Dispersive X-Ray Fluorescence (EDXRF) Analysis of Archaeological Obsidian (M.K. Davis et al.). Laboratory Obsidian Hydration Rates: Theory, Method, and Application (C.M. Stevenson et al.). Obsidian Hydration Dating at a Recent Age Obsidian Mining Site in Papua, New Guinea (W.R. Ambrose). Perspective in the 1990s on Method and Theory in Archaeological Volcanic Glass Studies (R.C. Green). Index.

ABOUT THE IAOS

The IAOS was established to:

1. develop standards for analytic procedures and ensure inter-laboratory comparability;
2. develop standards for recording and reporting obsidian hydration and characterization results;
3. provide technical support in the form of training and workshops for those wanting to develop their expertise in the field, and;
4. provide a central source of information regarding the advances in obsidian studies and the analytic capabilities of various laboratories and institutions.

Membership

The IAOS needs membership to ensure success of the organization. To be included as a member and receive all of the benefits thereof, you may apply for membership in one of the following categories:

- Regular member $20.00/year
- Institutional member $50.00
- Student member $10.00/year or free with submission of paper to newsletter and copy of current student identification
- Life-Time Member $200.00

Regular members are individuals or institutions who are interested in obsidian studies, and wish to support the goals of the IAOS. Regular members will receive any general mailings; announcements of meetings, conferences, and symposia; bulletins; and papers distributed by the IAOS during the year. Regular members are entitled to attend and vote in Annual Meetings.

Institutional members are those individuals, facilities, and institutions who are active in obsidian studies and wish to participate in inter-laboratory comparisons and standardization. If an institution joins, all members of that institution are listed as IAOS members, although they will receive only one mailing per institution. Institutional members will receive assistance from, or be able to collaborate with, other institutional members. Institutional members are automatically on the Executive Board, and as such have greater influence on the goals and activities of the IAOS.

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CALL FOR ARTICLES AND INFORMATION

Submissions of articles, short reports, abstracts, or announcements for inclusion in the newsletter are always welcome. We accept electronic media on IBM-compatible 3.5" or 5.25" diskettes in a variety of word-processing formats, but WordPerfect (up to 8.0) or Word for Windows 95 is preferred. A hard copy of the text and any figures should accompany diskettes. (Contributions may also be e-mailed, by prior arrangement; see below.)

Deadline for the Winter *Bulletin* is 30 December 1998.

Send submissions to –
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IAOS Bulletin Editor
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To send short contributions, discuss article ideas, or make suggestions, please get in touch by e-mail:

sstewart@sonic.net

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http://www.peak.org/obsidian/obsidian.html

Don't forget to look here first with any of your questions about IAOS or about obsidian research around the world. Maps, photographs, pages of source listings, dozens of links, and the electronic IAOS Interdisciplinary Obsidian Bibliography.

Webmaster Craig Skinner has been working night and day to add new information and interest to the site. Look for an update in the next issue of the *Bulletin*.